

Summary of Projects to be Supported by NOAA OAR/NOS Through the Cooperative Institute for Arctic Research (CIFAR)

I. Projects Related to the Climate Regime Shift Hypothesis

Impacts of Climate Change on the Bering Sea Ecosystem over the Past 500 Years

PI: Bruce Finney, University of Alaska

Funding Amount: \$198,516

A paleo-oceanographic study on sediment cores and marine mammal bones from the southern Bering Sea will be conducted to provide information on longer term changes in population levels of Steller's Sea Lion. Cores samples will be evaluated to provide reconstruction of ecological changes. Sea Lion bones will be studied to look for isotopic signatures indicative of changes in trophic position of prey. Results from this study will be evaluated along with other available data to achieve a new understanding of natural variability of marine organisms at several levels of the food web and their relationships to climate and oceanic change. This longer term perspective is necessary to evaluate recent changes.

Retrospective Studies of Climate Impacts on Alaska Steller Sea Lions

PI: Edward Miles, University of Washington

Funding Amount: \$149,490

A compilation of physical and biological time-series data will be evaluated with proven and relatively novel analysis techniques to better understand the dynamics of western SSL population levels. Biological data for different species will be evaluated for coherent variations, and the biological data will be compared to physical data to evaluate climate impacts. The relationships between biological changes and physical changes will be evaluated over time, and also on a regional basis to explain differences between the eastern and western populations of SSL over the past few decades.

The Nature of North Pacific Regime Shifts and Their Impact on Steller Sea Lions

PI: Donald Percival, University of Washington

Funding Amount: \$120,000

To understand the possible role of regime shifts on population levels of SSL, one must first describe the regime shift. This project will clarify the underlying character of North Pacific regime shifts. A 100 year time-series of sea level pressure will be evaluated using different models to determine which provides a better definition of regime shifts. Additional analyses will compare variability in North Pacific regime shift indices to trends in SSL populations, and if possible in recruitment, in the Kodiak-Aleutian region and the southeast Alaska region.

Ocean Climate Variability as a Potential Influence on Steller's Sea Lion Populations

PI: Thomas Royer, Old Dominion University

Funding Amount: \$192,548

Historical oceanic and atmospheric data sets will be used to investigate the question of what drives the North Pacific gyre and its variability. Data sets to be evaluated include coastal hydrographic data, sea level, northern Oscillation Index, terrestrial climate data, altimeter measurements, and data on several marine bird and mammal species. The temporal variability of physical driving mechanisms will be compared to changes in populations of SSL, harbor

seals and northern fur seals. Past work in the Gulf of Alaska will be enhanced and extended into the Bering Sea. Evidence will be sought for any regional variability that may exist in addition to temporal variability.

North Pacific Climate Variability and Steller Sea Lion Ecology: A Retrospective and Modeling View – Part One

PI: Steven Bograd, Pacific Fisheries Environmental Laboratory

Funding Amount: \$155,000

This research will explore the relationship between climate variability and the ecosystems of the North Pacific and Bering Sea. It will examine the hypothesis that bottom-up effects in these areas related to large-scale climate change have contributed significantly to the decline in the western population of SSL. The importance of this factor in relation to other possible causes, such as prey reduction as a result of commercial fishing, will be assessed. This research will be used to consider future population trends of marine mammals in the North Pacific based on recent observations climate patterns. This part of the project will compile the historical data sets, develop methods for their analysis, and participate in the overall evaluation of historical and model-based data.

North Pacific Climate Variability and Steller Sea Lion Ecology: A Retrospective and Modeling View – Part Two

PI: Bruce Cornuelle and Art Miller, University of California, San Diego

Funding Amount: \$250,000

This component of the project will develop a coupled physical-biological model of the Gulf of Alaska and Bering Sea, interpret model results and participate in overall evaluation.

North Pacific Climate Variability and Steller Sea Lion Ecology: A Retrospective and Modeling View – Part Three

PI: Michael Alexander, NOAA-CIRES Climate Diagnostics Center

Funding Amount: \$58,190

This component will provide the coupled atmosphere-ocean model, conduct several model runs, analyze the results of these runs, and participate in the overall evaluation.

Interannual Variability of Biophysical Linkages Between the Basin and Shelf in the Bering Sea – Part One

PI: Wieslaw Maslowski, Naval Postgraduate School

Funding Amount: \$92,648

The coupled ice-ocean model developed at the Naval Post Graduate School will be used to identify interannual and interdecadal variations in the circulatory and mixing pathways by which nutrients are communicated from the deep ocean to the shelves in the Bering Sea and western Gulf of Alaska. This objective represents the foundation to understanding the biophysical coupling of physical processes to the food habitat that supports the higher trophic levels of fish, seabirds, and sea mammals, including the SSL. In contrast to previous field studies, which have investigated these processes in localized areas, this study will include a broad regional analysis into which altimeter and field data can be synthesized.

Interannual Variability of Biophysical Linkages Between the Basin and Shelf in the Bering Sea – Part Two

PI: Stephen Okkonon and Terry Whitledge, University of Alaska

Funding Amount: \$113,340

This component of the project will emphasize comparison of eddy field variability derived from the model and from altimeter data. Nutrient and productivity data will be collected and compiled, and then used to evaluate model-based results.

II. Projects Related to the Predator/Prey Hypothesis

Predator-Prey Investigations of Killer Whales and Steller Sea Lions in Alaska

PI: Andrew Trites, North Pacific Marine Mammal Research Commission

Funding Amount: \$200,820

This study will address a key question in the overall Steller sea lion issue **B** what role does killer whale predation play in the decline of Steller sea lions? Scientists from the North Pacific Universities Marine Mammal Research Consortium will involve the local mariner community to assess knowledge of the abundance and distribution of killer whales, and initiate a photo-census to keep track of whales in the region. This information will be used to estimate the numbers of killer whales, and compare western regions (where SSLs are in decline) to eastern regions (where populations are stable). Direct observations of killer whale predation will estimate the impacts of predation on recovery of SSL populations. Data derived will be incorporated into a model of killer whale predation, which is funded through the N. Pac. Marine Mammal Research Commission under the umbrella of SSL funding provided to them.

The Role of Physiological Constraint in the Acquisition of Foraging Ability: Development of Diving Capacity in Juvenile Steller Sea Lions

PI: Jennifer Burns, University of Alaska, Anchorage

Funding Amount: \$153,924

One purported cause of SSL decline is a reduction in juvenile survival. This proposal addresses that issue directly by providing knowledge about how juveniles forage, and what constrains their feeding ecology. This work will examine the diving capacity of juvenile SSLs, and how that diving ability may change with development. As a juvenile SSL grows, their blood and muscle tissues are able to store more oxygen for longer dives. This means that during the juvenile stage, they are limited in their ability to forage, and may be operating close to their physiological limit. This in turn provides support for the hypothesis that changes in the prey base will affect juveniles first.

This study will collaborate with ongoing work by the National Marine Mammal Laboratory in the collection of animals for physiological measurements. The results should allow determination of when and why juveniles are most vulnerable to ecological disturbances (including prey removal), and should help identify those factors that have a high probability of impacting successful recruitment.

Seasonal Assessment of Prey Competition between Steller Sea Lions and Walleye Pollock

PI: Robert Foy, University of Alaska, Kodiak

Funding Amount: \$202,308

The role of pollock as a competitor of Steller sea lions for prey has not been examined, yet the diets of pollock and SSLs overlap in forage fish and juvenile pollock. This study will determine the current importance of pollock in the diet of SSLs and adult pollock to predict the importance of pollock to the population status of SSLs as ocean conditions and fish communities change. Both commercial catches of pollock and directed research cruises will be used to assess pollock diet. Diet of SSLs is being evaluated by the Gulf Apex Predator study, and this study will provide interaction and collaboration with that program. Ultimately, the project could address the efficiency and effects of restricting pollock harvests inside SSL critical habitat areas.

Investigation of Foraging Behavior of Steller Sea Lions in the Vicinity of Kodiak Island, Alaska

PI: Richard Thorne, Prince William Sound Science Center

Funding Amount: \$541,200

PI: James Churnside, NOAA Environmental Technology Laboratory

Funding Amount: \$156,300

This project will locate and quantitatively assess the overwintering herring and SSL population in the vicinity of Kodiak Island. Their distributions in the west will be compared to those in the east (Prince William Sound, supported by other funds) during the crucial fall-winter feeding period. This will provide direct observational evidence of SSL foraging behavior, a current gap in knowledge about SSLs. Both acoustic (in water) and LIDAR and infrared (remote aerial) surveys will be used to provide synoptic information about SSL and herring distributions. Predator distributions will be overlain with prey in GIS format, with characteristics such as depth, species composition, and numerical density noted. Results can contribute to the understanding of the herring-limited hypothesis, especially during the winter season. This project is in collaboration with ongoing work by the Prince William Sound Science Center and the Alaska Department of Fish and Game.

III. Projects Relating to Both the Climate Change and Predator/Prey Hypotheses

Proceedings and Summary for the Public of a Workshop on “Is It Food II”

PI: Ronald Dearborn, University of Alaska

Funding Amount: \$23,300

This project will permit preparation of both technical and summary reports of the workshop to be held in Seward in late May 2001. The Alaska Sea Grant program will prepare the reports for publication and distribute them widely.

Climate-driven Bottom-up Processes and Killer Whale Abundance as Factors in Steller Sea Lion Population Trends in the Aleutian Islands – Part One

PI: George Hunt, University of California, Irvine

Funding Amount: \$405,634

This project is a large, integrated ecosystem study. It comprises measurements of primary production, zooplankton distribution and abundance, forage fish distribution, and seabird foraging as an indicator of prey concentrations, and killer whale distribution and abundance in regions where SSL populations are stable and where they are declining. Collaboration with the National Marine Mammal Laboratory (funded

with other sources) will allow determination of diet and foraging locations of SSLs, and abundance estimates and identification of killer whales in the region. These measurements will be taken in conjunction with ongoing physical and nutrient measurements taken by the NOAA Pacific Marine Environmental Laboratory (funded by OAR as part of the overall SSL funding). These integrated studies will be conducted both in an area where SSL populations are in decline (Seguam-Amukta Pass area), and where they are stable (Akutan-Unimak Pass area). Comparisons of the two regions will provide insight into the physical and biological factors affecting SSL population declines. This will provide the first comprehensive investigation of the ecosystem supporting SSLs in critical habitat areas. Research cruises will be undertaken in summer of 2001 and again in summer of 2002. This collection of studies will be the first multi-disciplinary, integrated study of the ecosystem in the critical habitat of western population of SSL.

Climate-driven Bottom-up Processes and Killer Whale Abundance as Factors in Steller Sea Lion Population Trends in the Aleutian Islands – Part Two

PI: Kenneth Coyle, University of Alaska

Funding Amount: \$694,218

This is the zooplankton component of the overall study described above and also includes the funds required for a cruise on the R/V Alpha Helix in summer of 2002.